REPORT DOCUMENTATION PAGE

Form Approved
OMB NO. 0704-0188

1. AGENCY USE ONLY (Leave Blank)

2. REPORT DATE
August 10, 2004

3. REPORT TYPE AND DATES COVERED
Final Report 7/15/02-7/14/04

4. TITLE AND SUBTITLE
High Quality Image and Video Compression for Lossy Packet Networks

5. FUNDING NUMBERS
DAAD19-02-1-0309

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8. PERFORMING ORGANIZATION
REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U. S. Army Research Office
P.O. Box 12211
Research Triangle Park, NC 27709-2211

10. SPONSORING / MONITORING
AGENCY REPORT NUMBER

42616.3-CI

11. SUPPLEMENTARY NOTES
The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.

12 a. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

12 b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This project addressed compression of images and video using group testing. We implemented a video codec called group testing for video (GTV) that uses the discrete cosine transform (DCT), followed by bit-plane coding of the DCT coefficients. GTV outperforms H.263 at medium-to-high bit rates.

We also developed several new rate control algorithms to work with GTV, taking advantage of its ability to assign very precise numbers of bits to each frame to achieve constant, or near-constant, quality per video frame. Constant quality video is important because it means that there are no glitches or objectionable artifacts in the video. Usually, when a scene change occurs, there is a noticeable drop in quality because more bits should have been allocated to the frames around the scene change, and/or frames could be dropped.

We are currently implementing some of the features of the new H.264 video coding standard in GTV. These include multiple-frame motion compensation, variable block-size motion compensation, quarter-pixel motion compensation, and 4X4 integer DCTs. These new features are leading to improved video quality over our initial GTV coder.

14. SUBJECT TERMS

Video compression, wavelets, rate control, constant-quality video, H.263, H.264

15. NUMBER OF PAGES
4

16. PRICE CODE

17. SECURITY CLASSIFICATION OR REPORT	18. SECURITY CLASSIFICATION ON THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	**UNCLASSIFIED**	**UNCLASSIFIED**	**UL**

NSN 7540-01-280-5500

Standard Form 298 (Rev.2-89)
Prescribed by ANSI Std. 239-18
298-102

REPORT DOCUMENTATION PAGE (SF298)
(Continuation Sheet)

1) Manuscripts – Copies of these were sent earlier this year. The IEEE Data Compression Conference is a peer-reviewed conference.

   a) Gidon Shavit, Michael Ringenburg, Jeff West, Richard E. Ladner, and Eve A. Riskin, "Group Testing for Video Compression," Proceedings of IEEE Data Compression Conference, pp. 212-221, March 2004.

   b) Michael Ringenburg, Richard E. Ladner, and Eve A. Riskin, "Global MINMAX Interframe Bit Allocation for Embedded Video Coding," Proceedings of IEEE Data Compression Conference, pp. 222-231, March 2004.

2) Personnel

   a) Computer Science and Engineering Ph.D. student Michael F. Ringenburg was supported ½ time in Autumn 2002, ½ time in Spring 2003, and full-time in Summer 2003 to work on interframe bit allocation. Mr. Ringenburg received the M.S. in Computer Science and Engineering in Winter 2004.

   b) Computer Science and Engineering Ph.D. student Gidon Shavit was supported ½ time in Summer 2003, full-time in Autumn 2003, and full-time in Winter 2004 to work on Group Testing for Video. Mr. Shavit received the M.S. in Computer Science and Engineering in Spring 2003.

3) Inventions – None

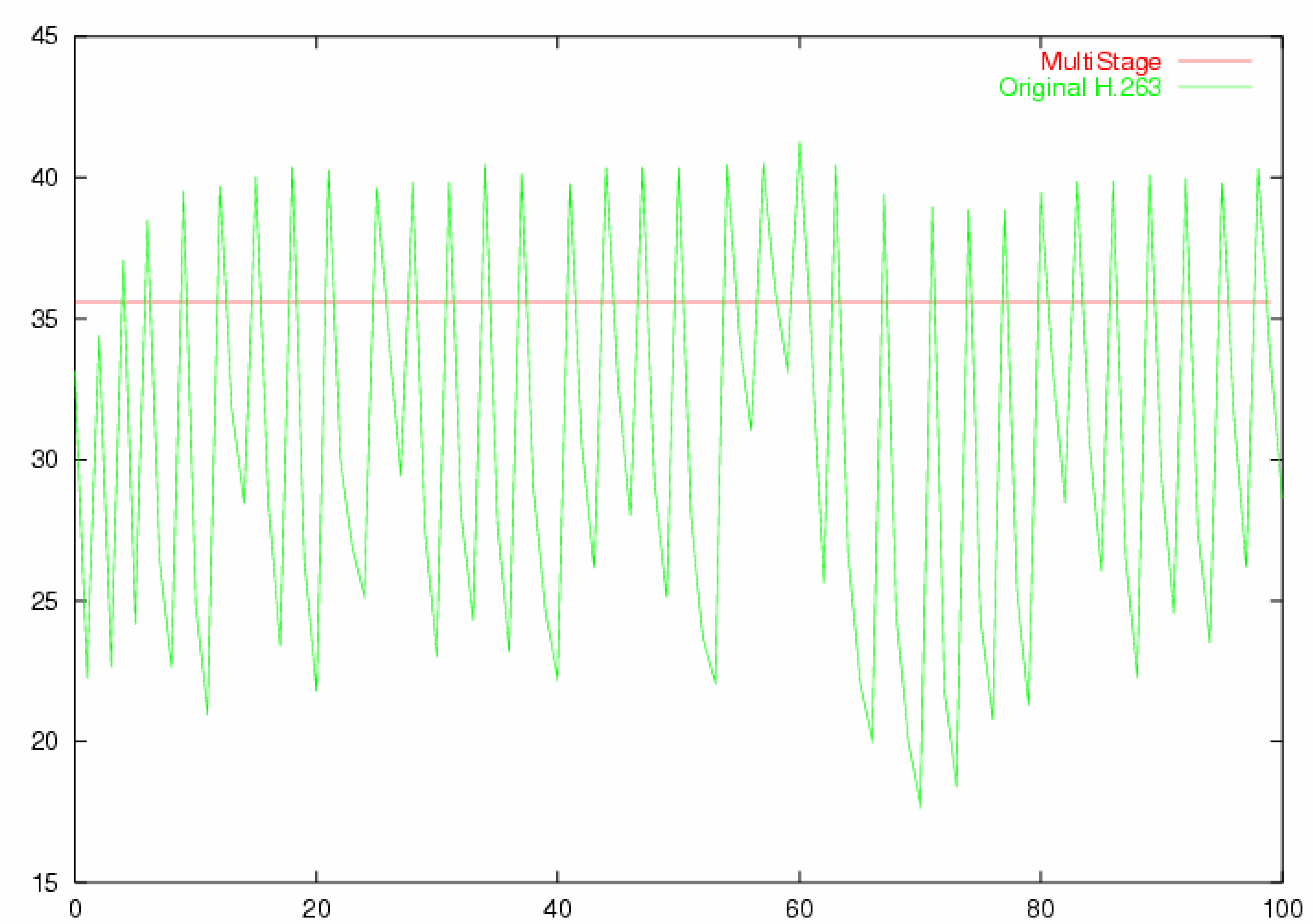
4) Scientific Progress and Accomplishments

We developed Group Testing for Video (GTV), a video compression algorithm based on the group testing for wavelets coder of Hong and Ladner. This algorithm produces a video stream that has a constant bit rate across the frames of the video sequence. GTV uses the discrete cosine transform followed by bit-plane encoding. It produces an embedded bitstream, meaning that it is straightforward to control the bits allocated to each frame. We further improved GTV by implementing better classification criteria and cross-frame adaptivity. We also adapted features from the new H.264 video compression standard to GTV. These

include 4X4 block transforms, variable block size motion compensation, quarter-pixel resolution motion compensation, and multiple reference frame motion compensation.

We also developed two fast rate control algorithms for compressed video. We developed several new algorithms, the MultiStage and Ratio algorithms, for rate control that provide near-constant quality. These algorithms work with GTV, taking advantage of the ability to assign precise numbers of bits to each frame using GTV. Constant quality video is important because it means that there are no glitches or objectionable artifacts in the video. Usually, when a scene change occurs, there is a noticeable drop in quality because more bits should have been allocated to the frames around the scene change. We are currently adapting these rate control algorithms to work with a non-embedded coder, such as H.263 or H.264 and can achieve near-constant quality for a quantization-based coder such as H.263. This has been a challenge because the quantization and lossless encoding steps of standard quantization-based coders do not give precise control over the number of bits allocated to each frame, as is the case for an embedded coder like GTV.

In the Figure, the quality of our MultiStage algorithm applied to a quantization-based video coder is compared against a standard rate control algorithm for H.263. The quality of the MultiStage is constant while the H.263 quality varies widely. In addition, the average quality of the MultiStage algorithm is higher.



5) Technology Transfer – none. We have contacted RealNetworks, Inc. to adapt our MultiStage algorithm to a quantization-based coder so that they can use it with their proprietary codec.